

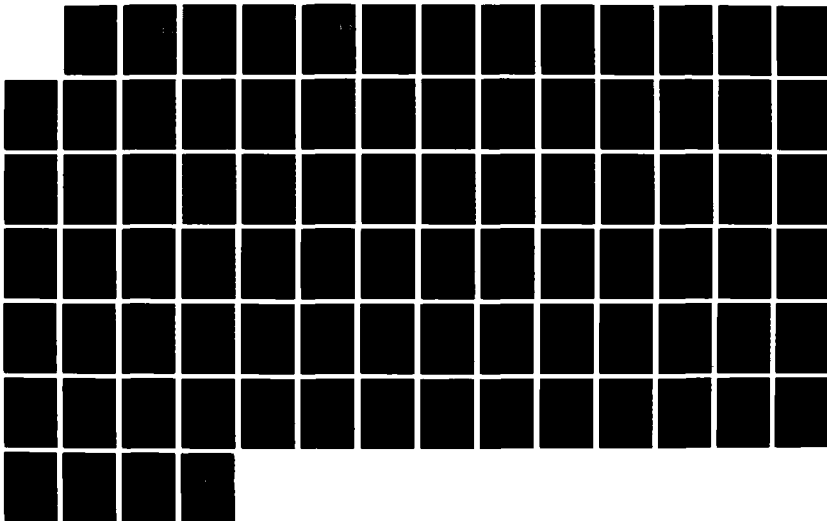
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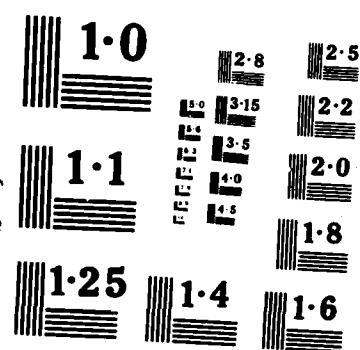
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Abstract

The purpose of this study was to examine and model electronic mail systems available to USCENTAF/SC planners at Shaw AFB and then compare them to a model of the AUTODIN communications system. A quantitative comparison of each model resulted in an overall most advantageous model. Each model's strengths and weaknesses were reviewed to determine if the overall most advantageous model was best for all situations.

Electronic mail systems available for use by USCENTAF/SC planners at Shaw AFB included Honeywell 6000 electronic mail services and facsimile. Electronic mail services available on the Honeywell 6000 computer were mail, terminal-to-terminal and terminal-to-console. The facsimile service available was for unclassified transmissions only.

The AUTODIN communications system is used by USCENTAF/SC planners for secure text message transmissions to their counterparts at Langley AFB. AUTODIN messages are sent to Langley at least daily by USCENTAF/SC planners.

Models of each electronic mail system found were constructed as well as a model of the AUTODIN communications system. These models were similar to flow charts that depict information flow and times required to complete the information flow.

These models were then compared using a rank ordered variant of the common sense approach to software cost model selection. The Honeywell 6000 electronic mail services were rated most advantageous using the rank ordered variant. It is important to remember that electronic mail services discussed in this thesis are not to replace but rather augment the use of AUTODIN and no single system is most advantageous in every situation.

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ELECTRONIC MAIL FOR USCENAF TACTICAL
COMMUNICATIONS PLANNERS

THESIS

William F. Severin
Captain, USAF

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ELECTRONIC MAIL FOR USCENTAF TACTICAL
COMMUNICATIONS PLANNERS

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Information Resource Management

William F. Severin
Captain, USAF

December 1987

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Abstract

The purpose of this study was to examine and model electronic mail systems available to USCENTAF/SC planners at Shaw AFB and then compare them to a model of the AUTODIN communications system. A quantitative comparison of each model resulted in the overall most advantageous model. This thesis had six basic objectives: (1) What forms of electronic mail are available to USCENTAF/SC planners at Shaw AFB; (2) Why and how often do USCENTAF/SC planners use the AUTODIN communications system to communicate with their counterparts at Langley AFB; (3) Create an AUTODIN communications systems model to illustrate how the AUTODIN system is used to transmit a message between planners; (4) Develop an electronic mail communications model for electronic mail systems found on the Honeywell 6000; (5) Develop separate models for electronic mail systems that do not use the Honeywell 6000 but are still available to USCENTAF/SC planners at Shaw AFB; (6) Finally, compare the models to determine the advantages and disadvantages of each. This was accomplished by analyzing each model to determine the overall most advantageous system. Then each model's strengths and weaknesses were reviewed to determine if the overall most advantageous model was best for all situations.

Electronic mail systems available for use by USCENTAF/SC planners at Shaw AFB included Honeywell 6000 electronic mail services and facsimile. Electronic mail services available on the Honeywell 6000 computer were mail, terminal-to-terminal and terminal-to-console. The facsimile service available was for unclassified transmissions only.

The AUTODIN communications system is used by USCENTAF/SC planners for secure text message transmissions to their counterparts at Langley AFB. Typical examples of this message traffic include classified frequency requests and unclassified requests for service (RFS). AUTODIN messages are sent to Langley at least daily by USCENTAF/SC planners.

Models of each electronic mail system found were constructed as well as a model of the AUTODIN communications system. These models were similar to flow charts that depict information flow and times required to complete the information flow.

These models were then compared using a rank ordered variant of the common sense approach to software cost model selection. The Honeywell 6000 electronic mail services were rated most advantageous using the rank ordered variant. It is important to remember that electronic mail services discussed in this thesis are not to replace but rather augment the use of AUTODIN and no single system is most advantageous in every situation.

ELECTRONIC MAIL FOR USCENTAF TACTICAL COMMUNICATIONS PLANNERS

I. Introduction

Background

United States Central Command Air Forces (USCENTAF) are tasked to provide air forces for rapid deployment to the United States Central Command (USCENTCOM) area of responsibility. The United States Central Command Air Forces Communications and Computers Directorate (USCENTAF/SC) planners are tasked to plan for tactical communications to support deployed USCENTAF forces. Rapid and accurate communications between USCENTAF/SC communications planners at Shaw AFB SC and Air Force Readiness Command Communications and Computers Directorate (AFRED/SC) communications planners at Langley AFB VA are imperative to ensure adequate communications support will be available for Commander USCENTAF (COMUSCENTAF) forces at their deployed location. The AFRED/SC communications planners at Langley AFB are responsible for planning the deployment of tactical communications resources while USCENTAF/SC communications planners plan for the employment of those tactical communications resources once they arrive in the USCENTCOM area of responsibility. To adequately coordinate the deployment of tactical communications resources, USCENTAF/SC communications planners require fast and secure text telecommunications with their counterparts at Langley AFB.

Specific Research Problem

Presently, common-user communication systems (those shared communications systems that are available to all members of any military organization requiring official telecommunications services) such as AUTODIN (AUTOMated Digital Network) and AUTOSEVOCOM (AUTOMatic SEcure VOice COMMUNICATIONS) are available to USCENTAF/SC communications planners to plan for the employment of tactical communications resources. This study assumes that, during a contingency, use of AUTODIN will increase. If the use of AUTODIN is significant the system can quickly become ineffective for transmitting time sensitive information due to excessively long service times from writer to reader. This delay in the transmission of text messages can seriously degrade the planning process. Poor coordination between communications planners during the initial planning phases of any operations, either exercise or real world, could result in poor communications support for deployed USCENTAF forces. USCENTAF/SC communications planners require more than AUTODIN communications systems to better communicate with their counterparts at Langley AFB.

Justification

Information systems are increasing in both numbers and varieties in the USAF today. To make efficient and effective use of these new information systems, USCENTAF/SC personnel must be made aware of the advantages and

disadvantages of using new information systems such as electronic mail.

The use of electronic mail would provide another communications system for USCENTAF/SC planners to use to transmit text messages during a contingency. The availability of secondary text message communications systems would mean reduced communications delays. Also, electronic mail systems used on the Honeywell 6000 computer system would not only provide another communications system to reduce the delay in communications but would provide a more dedicated communications system with fewer users and therefore reduce delays in access to communication systems.

Scope and Limitations

This research was limited to examining electronic mail systems available to USCENTAF communications planners for communicating with their AFRED counterparts at Langley AFB. This thesis was limited to the technical aspects of comparing AUTODIN and electronic mail services. Management considerations for using these services, such as message coordination through the chain of command, are not included.

For the purposes of this thesis, electronic mail was defined as "a service that enables users to leave messages and send letters or documents from terminals to a central data file for later retrieval by the recipient" (14:305) (the central data file may or may not be part of a computer,

as in the case of facsimile where the central data file might be an office).

This study focused specifically on the USCENTAF communications planning activities and does not necessarily apply to other planners in other theaters. Coordination with tactical planners at HQ Air Force Communications Command (AFCC) or Combat Communications Groups is also not addressed in this study. However, by adding remote Honeywell 6000 terminals at combat communications group locations, tactical communications planners at those locations could benefit from the advantages to be discussed in this research.

Also not included are various other forms of electronic mail used by other military or civilian organizations that are not available at Shaw AFB (such as electronic bulletin board service and the Defense Data Network). Further, although AUTODIN transmits messages electronically, it is not considered a form of electronic mail in this study. This research does not include USCENTAF operations, logistics, or other functional area planners. Any conclusions drawn apply specifically to USCENTAF/SC communications planners only.

As previously stated, to make efficient and effective use of information systems, USCENTAF/SC personnel must be made aware of the advantages and disadvantages of using new information systems such as electronic mail. To accomplish

this goal, this thesis compared the electronic mail systems available to USCENTAF/SC planners to AUTODIN and revealed the advantages of using the electronic mail systems in addition to the AUTODIN system. Finally, this thesis showed that the electronic mail systems, discussed in this thesis, can be a very useful addition to the AUTODIN system.

Research Objectives

This research had the following objectives.

1. Determine what forms of electronic mail are available to USCENTAF/SC communications planners. This included all forms of electronic mail available to USCENTAF/SC communications planners at Shaw AFB, not just those available on the Honeywell 6000. This research specifically included electronic mail services that USCENTAF/SC planners could use to communicate with Langley AFB.
2. Determine why and how often messages were sent using the AUTODIN system to communicate with the planners at Langley AFB.
3. Create an AUTODIN communications system model to illustrate the current system that is used to transmit a message from one communication planner to another.
4. Develop an electronic mail communications model for electronic mail systems found on the Honeywell 6000.
5. Develop separate models for electronic mail systems

that do not use the Honeywell 6000 but are still available to USCENTAF/SC planners at Shaw AFB.

6. Compare the models to determine the advantages and disadvantages of each system, the overall most advantageous system, and whether or not the overall most advantageous model is best for all situations.

Summary

In summary, USCENTAF/SC planners require fast and accurate text telecommunications with planners at Langley AFB to support the deployment of tactical communications equipment for COMUSCENTAF exercises and contingencies. The present common-user communications systems may experience long delays during a contingency due to increased demand for their services. Electronic mail could provide another communications system to reduce some of the delays encountered by planners during this type of crisis. However, for USCENTAF/SC planners to take advantage of electronic mail services, they must be made aware of the availability and the advantages and disadvantages of using the services. To make USCENTAF/SC planners aware of these advantages and disadvantages, this thesis focused specifically on USCENTAF/SC planners and electronic mail services at Shaw AFB.

II. Literature Review

Introduction

The concept of electronic mail does not have a singularly accepted definition as one looks at the current literature on this subject. Instead of a distinct type of system coming to mind when electronic mail is mentioned, a variety of systems and forms exist in the category of electronic mail. Electronic mail varies from advanced computer-based message systems (CBMS) to teletype or facsimile (14:305). Electronic mail involves sending information electronically (as the term suggests), from the sender to the receiver, instead of by conventional postal or special courier which requires human handling or processing.

This chapter will consider the following two types of electronic mail systems:

1. Terminal-to-terminal CBMS
2. Facsimile

Other forms of electronic mail (such as electronic bulletin boards) are not discussed in this chapter because they are not available for USCENAF/SC planners to use.

This chapter will also reveal that electronic mail is not without disadvantages. The two main disadvantages are (1) users experiencing technical problems when learning the new system and (2) security. However, as will be shown, there are ways to overcome these disadvantages.

The technology of electronic mail is rapidly advancing. New directions in the field of electronic mail include features that combine it with voice communications to make more efficient use of communications lines. Although it has come a long way, Mortensen acknowledges that the truly advanced forms of electronic mail are still a developing technology (24:101).

Understanding Electronic Mail

According to Erik Mortensen, electronic mail has been around for longer than many of us would think. Electronic mail goes all the way back to the time of the telegraph. However, the more conventional concepts of electronic mail, like CBMS, had to wait for the convergence of computers and data communications technology. It has only been in the last five or six years that sophisticated forms of electronic mail, like CBMS, have been available. Earlier forms of electronic mail such as telex and facsimile have been around much longer.

Terminal-to-terminal CBMS

Background. Computer-based message systems, using terminal-to-terminal type configuration, are the most commonly recognized form of electronic mail systems to many users. When an organization develops significant electronic mail requirements, terminal-to-terminal CBMS electronic mail systems can meet the demand according to Mortensen. If an

organization really starts using electronic mail, it becomes financially attractive to consider the use of a terminal-to-terminal CBMS. Mortensen details the arrangement of terminal-to-terminal CBMS systems as terminals connected to a host computer with each individual given an electronic mailbox. A message sender can send a letter or message to a recipient's electronic mailbox using a store and forward technology that allows messages to be sent and received any hour of the day. The store and forward technology accepts the message from the sender and "stores" it until the recipient checks his electronic mailbox. The message is then "forwarded" to the receiver to be read or printed. This allows senders to transmit messages to recipients who are not on the system at the same time. The computer simply stores the information until the recipient enters the system and is forwarded his mail.

Kerr and Hiltz, of the Computerized Conferencing and Communications Center at the New Jersey Institute of Technology, have written on the subject of CBMS. When a user wishes to communicate with another user using a CBMS application, he will type a message at a computer terminal. This terminal is connected to a host computer that will structure, store, and process the communication. After the host has processed the electronic mail message, the recipient can then access his mailbox for the message (20:215).

Other authors feel CBMS electronic mail pushes the frontier of electronic mail uses. They suggest that electronic mail not only speeds up how we communicate with others but also affects with whom we communicate. In an article by Lee Sproul and Sara Keisler, the idea that CBMS electronic mail can possibly change the flow of information in an organization and therefore change the power structure is explored: 'But we believe that electronic mail may do more than speed up information exchange, it may also alter the distribution of information in an organization, that is, it may change who has what information' (37:1492). As an example, if an urgent message requesting frequencies for a USCENTAF deployment can be sent directly from the USCENTAF/SC frequency manager to the AFRED/SC frequency manager, then upper and mid-level management is left out of the communications loop. This ability to work action officer to action officer alters the distribution of information in both organizations. Without commenting on the advantages or disadvantages of altering the distribution of information, allowing action officers to communicate directly, instead of through management coordinated and approved correspondence, changes the distribution of the information.

Remote Terminal Message Processor. USCENTAF/SC planners have access to electronic mail services via remote terminals connected to a host Honeywell 6000 World Wide

Military Command and Control System (WWMCCS) computer at Langley AFB. WWMCCS was developed in the 1960s to aid in the planning and execution of United States military operations. The system has over eighty mainframe computers at approximately thirty locations. These separate locations are linked by dedicated data communications channels. As a command and control information system, WWMCCS contains the necessary tools to enable planners to deploy military forces in real world contingencies, such as the invasion of Grenada (21:284).

Electronic mail services, on the Honeywell 6000, are accessed through an application known as the Remote Terminal Message Processor (RTMP). According to the RTMP user's manual, the Honeywell 6000 computer contains the RTMP program for the primary purpose of providing WWMCCS users with a means to communicate with one another (6:2). The USCENTAF/SC tactical communications planner could enter his message into the Honeywell 6000 computer where the mail would then be held until the recipient accesses the time sharing system. When the recipient logs-on he is informed that electronic mail is in his box for review.

RTMP also has direct terminal-to-terminal electronic mail communication that allows users to send and receive messages directly (5:2-1). RTMP direct terminal-to-terminal communication requires the two individuals desiring to communicate with each other to be logged-on to RTMP at the

same time. Users can then communicate in an interactive mode similar to a telephone conversation; however, they use a keyboard and computer instead of a telephone instrument (6:2).

One of the most obvious advantages of terminal-to-terminal CBMS electronic mail, other than speed, is the ability to get the message to a person/destination efficiently and securely. David Hollick describes this efficiency using an example of a branch manager trying to get a message to his production manager. The branch manager has gone to see the production manager at the production manager's office, but when he arrives he notices that the production manager is not in. The branch manager has several options for getting his message to the production manager; he can dictate a note to the secretary, try again later, or leave a message in the production managers electronic mailbox. Leaving the message in the electronic mailbox is by far the most efficient method. The message will not be forgotten by a secretary and will certainly arrive at the manager's mailbox. The production manager can read the message as soon as he returns, and no one else will see it (17:92).

Facsimile

Another older and more common type of electronic mail is facsimile. Facsimile or fax, is a very easy way to communicate letters, maps, and even photographs. Fax

transmission involves scanning a page and encoding the information for transmission of the image, in shades of black and white, without identifying individual characters (14:561). The ability to transmit graphics is the reason fax is chosen by users like the National Weather Service.

When a document is transmitted by fax, the machine scans the document and electronically encodes the information for transmission over a variety of possible types of communications media such as satellite, microwave, or telephone line. However, the most common communications medium is a telephone line. At the distant end is usually an identical fax machine that receives the coded information and decodes the transmission back into the original document transmitted by the sender. Facsimile has been around for some time and is definitely not new. A man named Alexander Bain is credited with the invention of fax technology in 1843 (13:95). Facsimile generally had little or no application until the 1920s. Today, however, some principle uses include transmitting weather maps, photos, and fingerprints for suspect identification by law enforcement officials (14:561).

One of the chief advantages of fax electronic mail systems is that they are common. Because fax is so common, a user can generally rely on owning or having access to a fax machine. Fax machines have also been used by the American military for a number of years. USCENTAF

Headquarters has a fax machine available for use on a first-come-first-served basis by all personnel at USCENTAF Headquarters. This fax machine is used for transmission of unclassified documents only.

Another advantage of fax machines is that they are relatively easy to use compared to other types of electronic mail. Fax machines at some military locations are left unattended with only a brief set of instructions for the user, thereby demonstrating the point that facsimile machines are easy to operate. Gerrard discusses how easy it is to use a fax machine. Using an automatic document feeder, some fax machines can be left alone to transmit up to thirty documents to any destination. All the user has to do is dial the correct party and ensure the communications connection is complete (13:97). Facsimile machines still provide accuracy and security: 'Facsimile really comes into its own where there is a need to transmit time-vital or confidential documents, or where a high degree of accuracy or authenticity is required' (13:97).

Perhaps the chief advantage of CBMS and fax is the speed of communications of information, according to Alan Thompson, a consultant for ICFC Consultants Limited. He explains that many organizations turn to electronic mail systems because of the need to overcome a specific problem identified in the organization (38:52). Faster flow of information allows decision makers more time to study

problems and arrive at better solutions. This speed advantage is an important consideration for USCENTAF/SC communications planners during execution planning for deployment of communications assets.

Disadvantages of Electronic Mail

For electronic mail to expand and achieve its full potential, present disadvantages must be overcome. These disadvantages include, but are not limited to user technical problems and security.

Technical Problems. A serious problem faced by many new users of electronic mail is the feeling of being technically lost. This feeling is usually found with people that use the more complicated systems such as CBMS, as opposed to fax users. Hancock states that an initial learning curve can be a considerable stumbling block for a new user for the following reasons:

1. MODulate DEModulate (MODEM) connections
2. Understanding the communications package
3. Setting the communications parameters
4. Dialing up the system
5. Logging in

Each of these reasons presents major obstacles for many organizations and users to overcome (15:242). Each encompasses a different set of problems and a different chance to make a mistake that is difficult if not impossible from which to recover. Hancock does not discuss solutions

to these problems, but a strategy for overcoming these disadvantages should include extensive education and initial supervision by knowledgeable personnel. If this strategy is not enough, hiring help outside the organization can ease this disadvantage to an insignificant nuisance. This disadvantage of feeling technically lost cannot be overemphasized. When combined with a lack of quality published materials showing how to install and operate the hardware and general distrust of computers, the frustration can be the cause of failure before the system is ever tried. Honeywell 6000 users have only to read the users manual to learn how to take advantage the services offered by the computer. Also, formal courses are taught on how to use the Honeywell 6000 thereby mitigating these problems.

Security. The problem of security has been around since the beginning of early crude forms of communication and has continued through to the age of computer communications (30:97). The security measures taken to protect electronic mail systems must include protection from both the young "hacker," trying to have some mischievous fun, as well as the serious professional electronic eavesdropper, trying to steal defense secrets. The security measures taken against both types of intruders are similar. Electronic mail systems must restrict access to only authorized users to prevent the transmission or creation of a false message or the compromise of a valid message.

Access must be granted to a sender or receiver that is compatible with the sender or receiver's security clearance within the system (30:96).

Solution of this problem may include physical security measures and non-dial communications lines. In CBMS systems, limiting access to the computer can provide an extra security measure for the electronic mail users relying on that computer for message transmission. One way to limit access to a computer, and thus its electronic mail capabilities, is to use a password system that allows the computer to recognize only those users that log-on with a valid password. According to Harvey Dietel, passwords are the most common authentication scheme used today (8:451).

The Honeywell 6000 computer system uses a user-id (user identification) and top secret password authentication scheme to provide the kind of security mentioned by Dietel. Dietel had only a limited solution to this problem. In the Honeywell 6000 system, dedicated non-dial telephone lines and password protection provide layered security. When the terminals are connected to the host computer by dedicated non-dial telephone lines, the potential intruder cannot gain access by programming his system to dial telephone numbers until he gets lucky and rings a computer's confidential dial-up telephone.

Although Price concentrated on the obvious ways of gaining access to an electronic mail system mentioned above,

he does include some less obvious covert methods. Line taps on telephone lines and electronic bugs surreptitiously placed in software programs are included in his list of covert methods.

Wiretapping, or line taps, of information transmitted between two computers can be divided into either passive or active wiretapping. Passive wiretapping is either listening in on a line or performing traffic analysis on the line. Active wiretapping is the altering, manipulating, false insertion, or the deleting of messages. Passive wiretapping can be effectively prevented but not easily detected. On the other hand, active wiretapping cannot be easily prevented but is more easily detected. Any security system must strive to prevent both active and passive wiretapping (29:70).

Price did not mention ways to counter the problem of telephone line taps. One effective counter measure is for the organization to wire its own internal electronic mail system with fiber optic cable instead of traditional copper wires. The advantage of fiber optic cable over traditional copper wire is that fiber optic cable cannot be tapped into without a loss of signal that can be detected by the users. Traditional copper wires carry radio frequency energy that radiates from the wire. This radiated energy is captured by the telephone tap without a loss of signal between transmitter and receiver. Fiber optic cable carries light

frequency energy that does not radiate from the fiber. If the fiber optic cable is tapped into, a complete loss of signal between the transmitter and receiver is experienced. This loss of signal can alert users of a possible breach of security.

New Directions for Electronic Mail

The coming years will see more users taking advantage of electronic mail than ever before. During the next decade, Lydia Holland predicts that electronic mail systems will become widely used. Electronic mail will not remain a toy or novelty but will instead become a vital tool for most businesses. The world will no longer see only a select few companies using electronic mail but will see electronic mail becoming as common as the telephone. She continues with the predictions that "Standards will enable disparate systems to interwork and directory inquiries to pinpoint a recipient anywhere in the automated world" (16:71). This ability to find any user through electronic mail will not be hampered by lack of compatibility but rather a planned security system. In the future, if you cannot reach someone by electronic mail, it will be because of system security rather than incompatibility.

One approach to predicting new directions for electronic mail, like many other technologies, is to predict the expansion of the present technology by the lessening or overcoming the disadvantages of using the technology

(34:33). Eliminating, or controlling, security problems will be a significant enhancement to electronic mail. According to G.K. Dalessandro "If a system can be made more resistant to unauthorized access through encryption, and security devices, we should expand" (3:125). Discussions with USCENTAF/SC planner, Master Sergeant Odom, confirmed the necessity of secure communications for frequency requests (24). Improving the security of electronic mail systems for USCENTAF/SC planners would be one such significant enhancement.

Other authors approach the future with more than just enhancements of technologies already available and are examining the combination of both voice and data on the same network (12:915; 19:823). Karvelas and Leon-Garcia wrote on adding voice capability to an integrated packet network using token-passing rings. Adding voice to an integrated packet network increases the efficiency of communications within the network. Fine and Tobagi describe a fully distributed access protocol for integrating voice and data on a local area network (12:915). They discuss how both voice and data can be combined together on the same network while satisfying technical requirements for voice and data transmission. Further, they developed a mathematical model of a system to provide a quantitative evaluation of the network. According to Fine and Tobagi, a large number of voice and data sources can be accommodated on the same

network (12:922). The significance of combining voice and data on the same network is that, as the price of communications increases, more efficient use of available communications is logical to keep down the costs of electronic mail systems.

Summary

This literature review defined the term electronic mail and gave several examples. Terminal-to-terminal computer-based messaging systems and facsimile types of electronic mail systems were discussed. These subjects were discussed to provide the reader with a basic understanding and appreciation of electronic mail systems. The advantages and disadvantages of electronic mail were examined to further the reader's understanding of electronic mail. Advantages such as speed, as in the case of the CBMS, or simplicity of use as in the case of fax, provide the reader with an understanding of the potential benefits of electronic mail and, therefore, a motivation for its use. Disadvantages, such as technical complexity and security, served to remind the reader that there are problems to be aware of when using electronic mail. Two predicted advancements in electronic mail technology are the mitigation of the disadvantages of complexity and security. In addition, a new direction for electronic mail is to combine it with voice conversations over the same communications network to make more efficient use of communications networks. Rounding out this

discussion, electronic mail systems are expanding at an accelerated rate and may become commonplace as discussed in the new directions for electronic mail section.

III. Methodology

Introduction

This chapter provides a detailed discussion of the methodology used in this thesis. In this chapter, the thesis was sufficiently detailed to allow the reader to reproduce the important aspects of this methodology to verify its accuracy (9:333). Each research objective outlined in chapter one was given a method for completion. The methods used to research the problem are stated after each research objective.

Electronic Mail at Shaw AFB

Research objective number one was to determine what forms of electronic mail are available for USCENAF/SC communications planners. This included all forms of electronic mail available to USCENAF/SC planners at Shaw AFB, not just those available on the Honeywell 6000. This research specifically included electronic mail services that USCENAF/SC planners could use to communicate with Langley AFB. A trip to Shaw AFB allowed first hand investigation of all the electronic mail services available to USCENAF/SC communications planners. See appendix A for the questions, as well as the reasons for the questions, asked of USCENAF/SC planners. Questions one and two of appendix A apply to this research objective. Telephone interviews with USCENAF/SC counterparts at Langley AFB confirmed the

availability of electronic mail services for communications with USCENTAF/SC planners (see appendix B).

AUTODIN Use by USCENTAF/SC

The second research objective was to determine why and how often messages were sent using the AUTODIN system to communicate with the planners at Langley AFB. Interviews with the officers in charge of USCENTAF/SC exercise and contingency planning sections were conducted to find out how often the AUTODIN system was used to send messages to their counterparts at Langley AFB. Questions three and four in appendix A were used to obtain this information. Each officer in charge provided an estimate of how many messages are sent to Langley AFB. This information established how much USCENTAF/SC planners rely on AUTODIN and provided additional justification for this thesis to examine additional ways to communicate with Langley AFB.

Research objectives three, four, and five required construction of various models. Each of these models contained the research variables of time (speed of service from planners at Shaw AFB to planners at Langley AFB), security (level of security such as secret or top secret), and accessibility (who can send messages to whom and are there special requirements to use the communications system).

a. The time research variable was extracted from Air Force Regulations for portions of the AUTODIN model from the

time the message is delivered to the base telecommunications center. Other portions of the model were constructed based on answers to questions seven, eight and nine, in appendix A, and questions put to Automatic Switching Center (ASC) experts. The total time variable for the AUTODIN and other models was the total time calculated for each model. Portions of the time variable for the electronic mail models were taken from research done on the Honeywell literature, telephone conversations with computer personnel at Langley AFB, and users' manuals for the Honeywell 6000 and facsimile electronic mail systems. This research was concerned with how fast one model is relative to the other model.

b. The security variable was measured by examining the overall security of the model. Air Force Regulations and system users' manuals were used to determine a system's security level. The highest level of classification that a model can support was determined and compared to the other models. Again, this yielded a relative comparison.

c. The accessibility variable considered the range of users that can participate in each system and any special requirements for a communications planner to use either the AUTODIN or the electronic mail systems. Typing skills and any other special requirements for access, such as user-ids and passwords, provided an accessibility rating for each model. Specific factors of accessibility were revealed by responses to questions asked in appendix A (questions eight

and nine), the site survey, researching the Honeywell 6000 literature, Air Force Regulations, and user manuals for other electronic mail systems. "DoD" is an example of a specific accessibility variable indicating that all Department of Defense personnel have access to the model.

AUTODIN Communications Model

Research objective number three was to create an AUTODIN communications model that accurately describes the current system that is used to transmit messages from one planner to another. The way USCENTAF/SC communications planners use AUTODIN (including message preparation prior to delivery to the base telecommunications center) was modeled so the AUTODIN system could be compared to the electronic mail systems found at Shaw AFB that are available to USCENTAF/SC communications planners. The AUTODIN model was constructed using the answers from interview questions three and four asked in appendix A and from related literature on AUTODIN architecture. Information required to build this model included the following:

- a. Estimates from administrative personnel as to how long it takes to type a one page message.
- b. An estimate of how long it takes to deliver that message to the telecommunications center (TCC).
- c. Information from Air Force Regulations to define the maximum amount of time allowed for the TCC to transmit the message to the Automated Switching Center (ASC).

d. An estimate of the average time required to process a message through the ASC according to ASC traffic analysis personnel.

e. A calculated time research variable from the information obtained in a, b, c and d.

f. A translation of the system security level to the security research variable.

g. A measurement of the accessibility research variable in terms of those personnel with access to the system.

Honeywell 6000 Electronic Mail

The fourth research objective was to develop an electronic mail communications model for electronic mail systems found on the Honeywell 6000. To meet this objective a model of the electronic mail systems available on the Honeywell 6000 was constructed from the literature available on the Honeywell 6000 and telephone conversations with Honeywell 6000 computer experts at Langley AFB.

To build this model, the following information was gathered:

a. A list of computer applications available on the Honeywell 6000 computer for electronic mail.

b. A calculated time research variable.

c. A translation of the system security level to the security research variable.

d. A measurement of the accessibility research

variable in terms of those personnel with access to the system.

Other Electronic Mail at Shaw AFB

The fifth research objective was to develop an electronic mail communications model for electronic mail systems that do not use the Honeywell 6000 computer. A model of the electronic mail systems not found on the Honeywell 6000, but still available to USCENTAF/SC at Shaw AFB, was constructed using data revealed by the site survey and by reviewing the users manuals for those systems. To create this model, the following information was gathered:

- a. The information gathered to satisfy research objective number one.
- b. A calculated time research variable.
- c. A translation of the system security level to the security research variable.
- d. A measurement of the accessibility research variable in terms of those personnel with access to the system.

To model the AUTODIN and electronic mail systems, a diagram similar to a flow chart was created for each system. Nodes containing required activities, such as typing a one-page message on a DD173 (message preparation form), were built. These nodes were connected by arrows that indicate the time required to perform the required activity in the node that the arrow originated from. For example, the arrow

from the node to type the one-page message on a DD173 was marked with the average time required to type a one-page message on a DD173. A total time required for each model yielded the time research variable as described in figure 1.

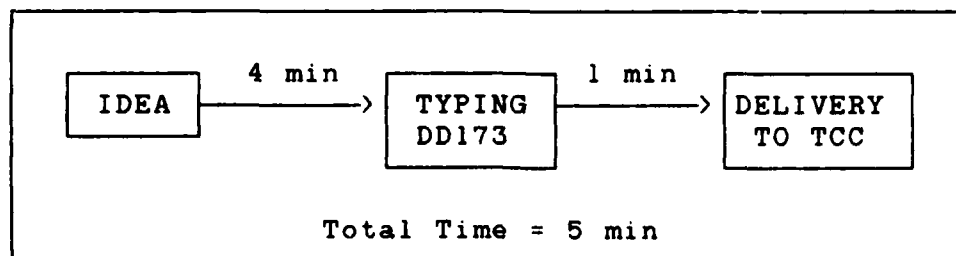


Fig 1. Partial AUTODIN Model

Electronic Mail Comparison

Research objective number six was to compare the models to determine which was the overall most advantageous. To adequately compare the models, a rank ordering variant of the weighted factors approach to software cost model selection, by Daniel V. Ferens was used (10:30). In a personal discussion, he elaborated on the similarities between his weighted factors method of model selection and the rank ordering variant used in this thesis. He also noted that the rank ordering of the weighted factors model selection method was not only acceptable but "might even be better" (11) than the original weighted factors model selection method.

To accomplish the rank ordering variant of the weighted factors approach to model comparison, the research variables

were given value ratings in order of relative importance. The research variables security, time, and accessibility were given value ratings one, two, and three, respectively.

Once the models were completed and the security, time, and accessibility variables were found, a matrix was constructed with the research variables and different electronic mail models to accomplish research objective number six. Research variables were in rows and the different models were in column form along the top in a comparison matrix similar to table I.

Table I. Sample Comparison Matrix

	MODEL 1	MODEL 2	MODEL 3
SECURITY	TS	TS	UNCLAS
TIME	20 sec	45 min	3 min
ACCESS	HW 6K	DoD	DoD

Legend: TS = Top Secret, UNCLAS = Unclassified
HW 6K = Honeywell 6000 users only
DoD = Department of Defense personnel

The research variables in table I are listed in order of relative importance (ie. security is more important than time, and time is more important than accessibility). These research variables are listed in this order of importance due to the security requirements and time sensitive nature of the USCENAF/SC mission.

The comparison matrix yielded the most advantageous and least advantageous models by relative comparison. For

example, the most secure model received a score of one relative to the least secure model that received the number equal to the number of models (since there are five models, the least secure model received a score of five). The fastest model received a score of one while the slowest received a score of five. Also, the most accessible model received score of one while the least accessible model received a score of five.

The value ratings were multiplied by the scores to yield a subtotal reflecting the importance of the research variable and how well the model faired competing against the other models. The subtotals were then added together to arrive at a total indicating, numerically, how advantageous each model was relative to another. The model with the lowest total was the most advantageous.

Summary

This chapter explained the methodology of this research. Research objectives from chapter one were assigned a method of completion to ensure completeness of this research. Electronic mail services available to USCENTAF/SC planners were researched by interviewing personnel at Shaw AFB. These interviews allowed the building of selected electronic mail models. A system to model the AUTODIN and electronic mail services was devised that included a diagram similar to a flow chart to illustrate each model. Research variables were defined to

compare each model. A sample comparison matrix was established, using a rank ordering variant of the weighted factors approach to software cost model selection, to compare each model.

IV. Analysis and Results

Introduction

The following results were obtained by conducting the research outlined in chapter three. Each research objective is restated, as in chapter one, and followed by the results obtained by performing the analysis as described in chapter three.

Electronic Mail at Shaw AFB

Research objective number one was to determine what forms of electronic mail were available to USCENTAF/SC planners. This included all forms of electronic mail available to USCENTAF/SC communications planners at Shaw AFB, not just those available on the Honeywell 6000. This research specifically included electronic mail services that USCENTAF/SC planners could use to communicate with Langley AFB. Discussions with USCENTAF/SC personnel revealed the following electronic mail services were available:

- a. Electronic mail services are available on the Honeywell 6000 computer using the WWMCCS Integrated Network (WIN). The host Honeywell 6000 computer is located at Langley AFB while remote terminals are located at various other Tactical Air Command (TAC) bases and connected to the host computer via high-speed data circuits. Langley Honeywell 6000 computer terminals are located at Shaw AFB in

the 9AF command post and in the HQ TAC/SC building housing USCENTAF/SC planning counterparts at Langley AFB (35).

b. USCENTAF/SC planner Captain Paul Rigney thought Defense Data Network (DDN) communications services were available, but he said he never used them. When asked why DDN was never used. He replied that the procedures for using the DDN were not known by the people with whom he wished to communicate (32). Unknown to Captain Rigney, at that time, was the fact that the DDN was not yet fully operational at Shaw AFB. The DDN network will not be modeled because it is not yet fully operational at Shaw AFB. According to the Data Processing Center Manager at Shaw AFB, the hardware is available but no software is available (28). Discussions with Lt Russel, DDN planner at Langley AFB, revealed DDN connectivity could still be 'some time' (35) in the future. No firm date for DDN connectivity was found. Also, DDN is a common user system (a shared communications system that will be available to all members of any DoD organization requiring official telecommunications services). Because the DDN is a common user system, it could become saturated and experience time delay problems similar to the AUTODIN system as discussed in chapter one.

c. Facsimile services are available for use by USCENTAF/SC planners at the USCENTAF Headquarter building. One fax machine, belonging to the USCENTAF Directorate of Intelligence (USCENTAF/IN), is currently available for

classified or unclassified information while the other fax machines on order by USCENTAF/DA will be used exclusively for unclassified information.

At present, fax is the only form of electronic mail used by the planners to communicate with Langley AFB. The fax is not used often by some planners, as Capt Paul Rigney said he used the fax only three times in as many years (32). AUTODIN and AUTOSEVOCOM were the main secure communication services used by USCENTAF/SC planners to communicate with Langley AFB.

AUTODIN Use by USCENTAF/SC

The second research objective is to determine why and how often messages were sent using the AUTODIN system to communicate with Langley AFB. AUTODIN is used to provide deployment coordination of tactical communications assets in support of COMUSCENTAF. Frequency requests and Requests For Service (RFS) are among the messages sent via AUTODIN (33). Frequency requests are classified messages that require multiple addressees for information purposes (25). Among the information addressees are Area Control Centers (ACC) that do not have access to the Langley Honeywell 6000 computer. Request For Service (RFS) traffic also includes multiple information addressees (27). AUTODIN messages originate from the different offices of USCENTAF/SC at different rates. The contingency plans office sends messages through the AUTODIN system at a rate of five per

week (32) while the exercise plans office uses AUTODIN at five times the rate of the contingency plans office, or 25 messages per week (33), according to the officers interviewed in each planing office.

AUTODIN Communications Model

Research objective number three is to create an AUTODIN communications model to illustrate the current system used to transmit a message from one communications planner to another. The AUTODIN communications service is used by the USCENTAF/SC planners like other users on Shaw AFB. The planner conceives an idea in his head that requires communications to his counterparts at Langley AFB. The planner then takes pencil and paper and creates a draft message for typing by unit administrative specialists. The message is typed by administrative specialists on a Department of Defense Form 173 (DD173). For example, a one-page immediate message requires approximately four minutes to type (2). The immediate message priority will remain the standard priority example throughout this thesis when referring to the AUTODIN model. The immediate message is then delivered to the base telecommunications center for processing and transmission. The distance from the office of the USCENTAF/SC planners to the telecommunications center is quite small and requires only two minutes to walk. The message is received at the telecommunications center by telecommunications specialists and checked for format and

other errors. Once the message is accepted by the telecommunications specialists, it is transmitted according to message priority (see table II) within the following specified time constraints in accordance with AFR 700-7:

Table II. Speed of Service Times

MESSAGE PRIORITY	SPEED OF SERVICE TIMES
ECP*	5 minutes
Flash	10 minutes
Immediate	30 minutes
Priority	180 minutes
Routine	360 minutes
* Denotes Emergence Command Precedence	

Keeping in mind that the standard message priority in this thesis is immediate, the reader will notice the speed of service time for an immediate message is 30 minutes, as indicated in table II. An immediate USCENTAF/SC message delivered to the telecommunications center may take as long as 30 minutes (4:4) before it is transmitted. Two good reasons exist for this possible delay. First, a message with a higher priority will be transmitted ahead of the immediate message. If a flash message is received at the telecommunications center after the immediate USCENTAF/SC message is accepted but before the immediate message can be

transmitted, the immediate USCENAF/SC message will be delayed at least until the flash message is transmitted. Second, each message is transmitted, within its priority classification, on a first-come-first-served basis. If ten immediate messages have already been accepted for transmission, the immediate USCENAF/SC message will have to wait its turn. Once the USCENAF/SC message is processed by the base telecommunication center, it is transmitted to an Automated Switching Center (ASC) for further transmission through the AUTODIN system (7:8).

At the ASC, the USCENAF/SC immediate message is held for transmission to another ASC, or base telecommunications center, according to the same rules and procedures used by the base telecommunications center (priority and time received). The ASC works on a "store and forward" concept that receives incoming messages and holds them (store) until time to transmit the messages (forward) to another ASC or base telecommunications center. The time required to process an immediate message through an ASC is at most one minute (22).

Once the USCENAF/SC immediate message is received by the base telecommunication center at Langley AFB, a telecommunications specialists will notify the addressee that an immediate message is available for pick up at the base telecommunications center. The addressee will then dispatch a courier to retrieve the message for action by the

addressee. The courier must provide proper identification to the base telecommunications center personnel to receive the message. Once the courier has the message, he will proceed back to his unit to distribute the message to the proper addressee in accordance with unit message distribution policy (see figure 2).

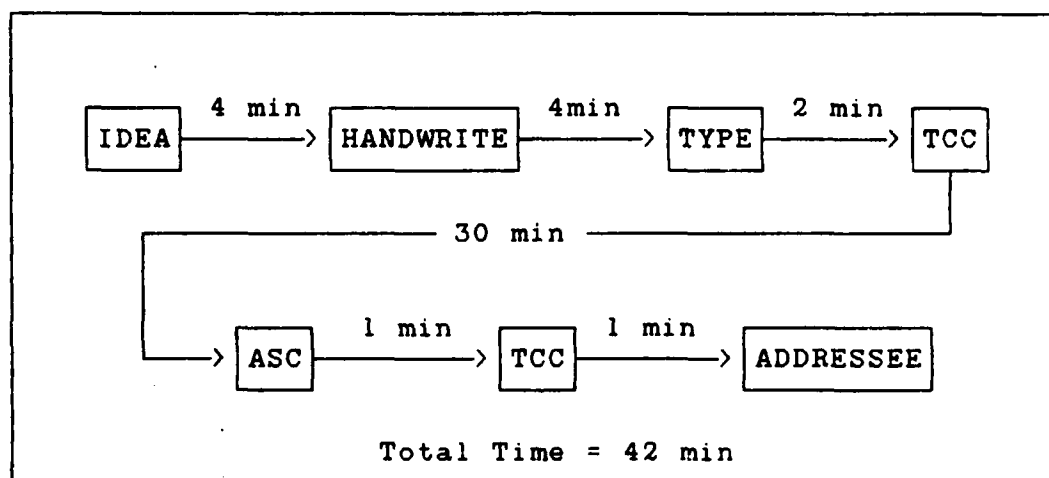


Fig 2. AUTODIN Model

The time research variable is 42 minutes, as a worst case, for an immediate message. Due to problems beyond the control of the communications unit commander, such as an excessive backlog of high precedence messages to be transmitted by the telecommunications center, at least 42 minutes must be allowed for message delivery using the AUTODIN system.

The AUTODIN system is secure for messages up to and including top secret, giving the model a top secret rating

for the security research variable. Users indicate the security level on the message and it is handled in accordance with established United States Air Force security regulations (7:66).

The accessibility research variable for this model is DoD world wide. Any DoD member can use the AUTODIN system for official message requirements to send messages to any DoD organization.

Honeywell 6000 Electronic Mail

The fourth research objective is to develop an electronic mail communications model for electronic mail systems found on the Honeywell 6000 computer system. According to the Remote Terminal Message Processor (RTMP) user's manual, the RTMP program on the Honeywell 6000 series computer has the primary mission of providing World Wide Military Command and Control System (WWMCCS) users with the capability to communicate with each other. For each of these types of communications, the USCENTAF/SC planner is required to use a Honeywell 6000 computer terminal located in the 9AF Command Post. RTMP has a total of three different ways for WWMCCS users to communicate with each other (6:2):

1. The first way WWMCCS users can communicate is by direct terminal-to-terminal communications. Each user desiring communications with another user must be signed on to RTMP at the same time as the other users. Each user will

then proceed to send or receive messages to or from other users. This interaction has no time limit and can theoretically continue as long as the participants desire.

2. Mail is the second way WWMCCS users can communicate with each other. RTMP allows WWMCCS users to send mail from one WWMCCS terminal to another. Mail is a store and forward concept that allows a user to send mail to another user that is not necessarily logged-on to the terminal at the same time. When using mail, the user simply types in his message for another user.

3. The third type of communication is Direct Terminal-to-Console that allows users to communicate with the WWMCCS computer console operators. This type of communication is restricted to only those users previously identified as requiring this special type of communication. Although this method of communications has a system level of top secret, the system console operator has no "need to know" and has not been granted access to the sensitive information to be transmitted by USCENTAF/SC communications planners to their counterparts at Langley AFB. Therefore, only unclassified information can be sent via this type of communication. The use of the Honeywell 6000 is modeled in figure 3 below:

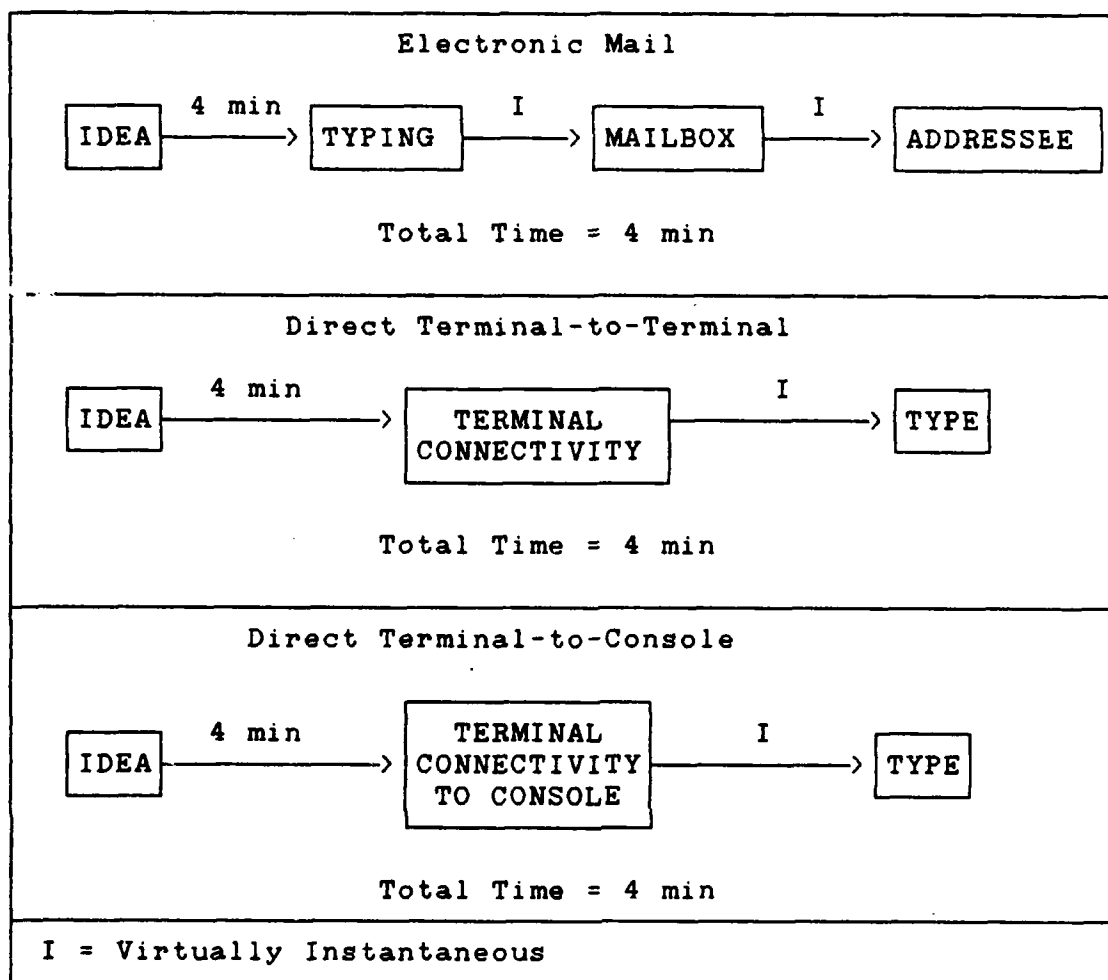


Fig 3. Honeywell 6000 Models

The time research variable for the Honeywell 6000 electronic mail and direct terminal to terminal systems is 'virtually instantaneous' (31).

The security research variable for the Honeywell 6000 computer system is top secret. All text messages with security classifications from unclassified through top secret can be sent on the Honeywell 6000 model.

The accessibility research variable for the Honeywell 6000 model, using the RTMP software application, is restricted to only Honeywell 6000 users on the host computer at Langley AFB. Shaw AFB terminals are connected to the Langley AFB host and therefore, this is not a problem for the Shaw AFB terminals. Honeywell 6000 users require a user-id and password to use any Honeywell 6000 applications, including the RTMP. Further, using the RTMP application requires that the user type his own message. Therefore, at least some elementary typing skills are required. Also, as mentioned earlier, USCENTAF/SC planners do not have their own terminals and therefore are required to share the Honeywell 6000 computer terminals located in the Ninth Air Force command post. The sum of above mentioned requirements make the Honeywell 6000 electronic mail system the most difficult model to gain access to, as these restrictions do not apply to the other models. Limiting the access to the Honeywell 6000 system (restricted) is what separates it from the AUTODIN and fax (common-user systems). The fact that the RTMP application on the Honeywell 6000 computer system is a part of a command and control system (6:2) restricts access to only command and control uses. To correctly model this fact, Honeywell 6000 systems score behind the AUTODIN and fax models in accessibility comparisons.

Other Electronic Mail at Shaw AFB

Research objective number five is to develop separate models for electronic mail systems that do not use the Honeywell 6000 computer system but are still available to USCENTAF/SC planners. One electronic mail system not found on the Honeywell 6000 is facsimile. For USCENTAF/SC planners to use the fax machines at Shaw AFB, the planner must first conceive the idea to be communicated. This idea must then be written in draft form and then presented to an administrative specialist for typing. It is important to note that a handwritten message could be sent by fax if required. Once the typing is complete, the message is delivered over to the appropriate fax machine at the 9AF HQ building for transmission (see figure 4).

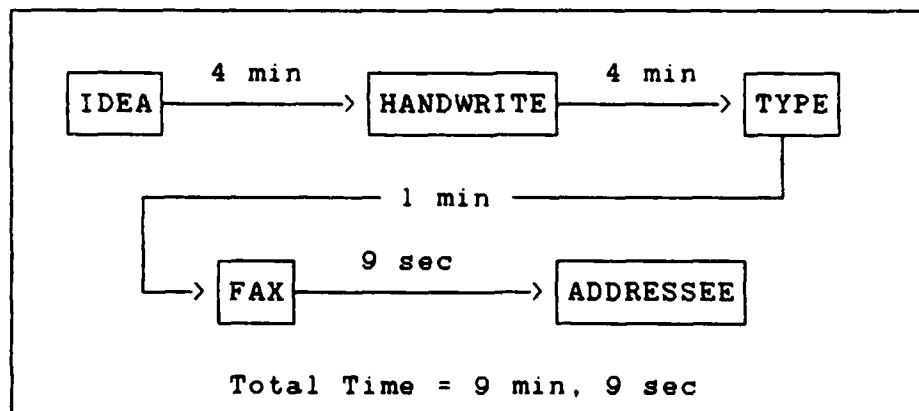


Fig 4. Facsimile Model

The time research variable for the fax model is just over nine minutes. Once the connection or handshake (a controlled two-way transfer of data across the telephone

line), (23:120) is completed between the two fax machines, transmission of a single 8.5 X 11 document requires only nine seconds.

The fax model is unclassified. It is not to be used for classified messages and therefore has an unclassified security research variable.

The accessibility research variable is for DoD personnel world wide. DoD official communications using the fax model require only a standard telephone line and compatible equipment on both ends of that line.

After arriving at the appropriate fax machine, the planner must wait for any other users that arrived ahead of him to use the fax. Although fax use is done on a first-come-first-served basis, priority can also be a factor determining when the planner can send his message. For example, if the planner is next in line to use the fax and a Colonel walks in and announces he needs to use the fax, the Colonel may move to the front of the line.

Once the planner has access to the fax machine, he must dial the distant end he wishes to transmit his information to and coordinate the reception. A delay may be encountered if a busy signal is received when attempting to dial the distant end.

Once the planner has telephone line connectivity, he can then transmit his message for his counterpart at the distant end to receive.

Fax machines commonly use telephone lines for their connectivity to other fax machines at a distant location. The Omnifax 9S is the unclassified fax machine available for common-user use at the USCENTAF headquarters building. This fax machine is for the user that needs to send "moderate to large volumes of documents" (26:3). According to the Teleautograph Corporation that manufactures the Omnifax machines, the 9S model is capable of four different modes of transmission. These modes are as follows:

1. Single Button Dialing
2. Keypad Dialing
3. OCR Faxcard
4. Programmed Operation

Single Button Dialing allows the user access to 32 different fax stations by pressing a single button (hence the name Single Button Dialing). Keypad Dialing allows for access to any one of 100 different fax machines by using a "2-digit abbreviation" (26:2). OCR Faxcard relies on an Optical Character Read (OCR) Faxcard to access a phone number written on a reuseable faxcard. The Programmed Operation uses a faxcard or keypad to access different Omnifax functions. The Omnifax 9S can be upgraded with a one megabyte memory, allowing it to operate in "a private communications mode which lets only those who enter the proper pass code retrieve confidential information received and stored in memory" (26:4). It is important to note that

this level of security does not meet National Security Administration (NSA) standards, and therefore the Omnifax 9S is not used to transmit classified information.

Electronic Mail Comparison

Research objective number six is to compare the models to determine the advantages and disadvantages of each; analyze each model to determine the overall most advantageous; and to determine if the overall most advantageous model is best for all situations.

The following comparison matrix (see table III) evaluates each model:

Table III. Comparison Matrix

	AUTODIN	HW 6K Mail	HW 6K Terminal	HW 6K Console	FAX
Security	TS	TS	TS	TS	UNCLAS
Time	42 min	I	I	I	10 min
Access	DoD	HW 6K	HW 6K	*	DoD

Legend: TS = Top Secret, UNCLAS = Unclassified
 HW 6K = Honeywell 6000 users only
 DoD = Department of Defense personnel
 I = Virtually instantaneous
 * = Impractical

Looking at the matrix, the reader will notice that both the AUTODIN and Honeywell 6000 models tie for the highest level of security of any of the models and therefore all

three share in receiving the score of one. The fax model, last in level of security, receives a score of two.

The Honeywell 6000 models tie for the fastest of all the models and receive a score of one. The fax model is the second fastest model and therefore receives a score of two. The AUTODIN model is the slowest, even assuming an immediate priority on the message, and receives a score of three.

Both the AUTODIN and fax models tie for the most accessible model because of their ability to be used by all DoD personnel. They both receive a score of one. Since the Honeywell 6000 terminal-to-terminal and mail models require users to be connected to the main frame computer at Langley AFB and must possess some typing ability, they are more inaccessible than AUTODIN or fax. Therefore, they both receive a score of two. The Honeywell 6000 console model is not intended for planner to planner communications. Although this would be a possibility in an extreme emergency (because the console is located at Langley AFB), it cannot be assumed that this service would be accessible under most contingency situations. For the purposes of this study, the Honeywell 6000 console model is impractical for routine use. However, it could be used if a contingency situation warranted it. The decision not to use the Honeywell 6000 console model is a management decision, not a technical limitation.

Multiplying the value ratings and the scores provides

the following subtotals that yield the totals indicating the most advantageous as indicated in table IV:

Table IV. Rank Ordered Matrix

	AUTODIN	HW 6K Mail	HW 6K Terminal	HW 6K Console	FAX
Security	1	1	1	1	2
Time	6	2	2	2	4
Access	3	6	6	*	3
Totals	10	9	9	-	11

* = Impractical

Appendix D illustrates the computations performed to arrive at the subtotal figures.

From the totals in the Rank Ordered Matrix (table IV), the Honeywell 6000 models tie for the most advantageous, followed by the AUTODIN and fax models. The order of overall most to least advantageous model is the Honeywell 6000 models, AUTODIN, and finally fax.

Summary

This chapter provided the results of the research done to complete this thesis. Each research objective has been researched according to the methodology found in chapter three. Electronic mail services available to USCENTAF/SC planners include the following:

1. Honeywell 6000 Electronic mail services
 - A. Terminal-to-terminal

B. Mail

C. Terminal-to-console

2. Facsimile

AUTODIN services were used on a daily basis for coordination with AFRED/SC planners. Electronic mail systems available to USCENAF/SC planners were discussed and models representing those systems were constructed. Those models were then compared to find the most advantageous system as defined by the research variables using a rank ordered variant of the weighted factors approach to software cost model selection. Honeywell 6000 systems were the overall most advantageous models.

V. CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter examines the conclusions reached by investigation of the analysis and results obtained from chapter four. This research produced conclusions based on the data collected and makes recommendations for using electronic mail systems found at Shaw AFB to augment AUTODIN services. Further research, to expand the knowledge this thesis explored, is also recommended in the form of a computer simulation study and a cost-benefit analysis study.

Conclusions

Alternatives to AUTODIN. Alternatives to AUTODIN, in the form of different types of electronic mail services, are available to USCENTAF/SC planners at Shaw Air Force Base. These alternatives are Honeywell 6000 electronic mail services as well as unclassified fax. Also, Defense Data Network (DDN) services are scheduled to be added as a common-user system available to USCENTAF/SC planners but as yet are unavailable.

AUTODIN Use by USCENTAF/SC. This research showed that USCENTAF/SC planners rely on AUTODIN daily for communications with their counterparts at AFRED/SC. Coordination of the deployment of tactical communications assets, in support of Commander USCENTAF (COMUSCENTAF) contingencies and exercises, calls for the daily use of AUTODIN, as

revealed in interviews with USCENTAF/SC planners. AUTODIN is used to send messages for requesting frequencies, for tactical radio equipment, and still other messages are for such things as Requests For Service (RFS) for communications equipment channelization. Because of communications requirements such as the two mentioned above, AUTODIN services are essential to USCENTAF/SC planners in performance their mission.

Most Advantageous Model. Models representing AUTODIN, Honeywell 6000 electronic mail services, and facsimile services illustrated how these communications services are, as in the case of AUTODIN and facsimile, or could be used, as in the case of Honeywell 6000 electronic mail, by USCENTAF/SC planners. A comparison of these models, using a rank ordered variant of the weighted factors approach to software cost model selection, revealed the order of the overall most advantageous to least advantageous models as, Honeywell 6000, AUTODIN, and facsimile (respectively).

No Best System for all Situations. This thesis showed the Honeywell 6000 electronic mail services to be more advantageous than AUTODIN. While this study did not recommend that the Honeywell 6000 electronic mail services replace AUTODIN, the rank ordered variant of the weighted factors approach to software cost model selection shows that Honeywell 6000 electronic mail services can provide adequate augmentation to AUTODIN. It is important to understand that

the overall most advantageous model is not always the most advantageous for all situations. For example, for the accessibility research variable, AUTODIN scored higher than the Honeywell 6000 models. If time is not critical, sending a message through the AUTODIN system might be more appropriate. In the case of a request for frequencies that requires coordination with other agencies without access to the Langley AFB Honeywell 6000 computer, AUTODIN is the most advantageous because other agency coordination is not part of the Honeywell 6000 electronic mail services. This example illustrates that no one best, or most advantageous model, is appropriate for all situations. The decision to use AUTODIN, or any other systems modeled, should be made by the manager after careful analysis of the requirements of a particular situation.

Facsimile Alternative. Facsimile services were not found to be more advantageous than AUTODIN when using the rank ordered variant of the weighted factors approach to software cost model selection. Fax was found to be very accessible and, although slower than the Honeywell 6000 electronic mail models, faster than AUTODIN. The biggest drawback to using facsimile is that only unclassified information can be transmitted. Since not all USCENTAF/SC communications are classified, as in the case of RFSS, facsimile should be considered as an alternative to AUTODIN for unclassified message traffic.

Recommendations

Electronic Mail to Augment AUTODIN. USCENTAF/SC should consider using Honeywell 6000 electronic mail as well as facsimile services to augment AUTODIN connectivity when appropriate. During contingency and exercise planning, Honeywell 6000 electronic mail services can provide an acceptable alternative/augmentation to AUTODIN communications to ensure the secure transmission of classified information to AFRED/SC planners. Facsimile services provide the same alternative/augmentation for unclassified information transmission. Also, the use of encrypted fax in the future should be examined. Adding an encrypted fax capability would provide another classified method for message transmission to Langley AFB.

Computer Simulation. Further refinement of the models constructed in this thesis will allow for computer simulation studies to verify the ranking of the models in terms of most to least advantageous. Simulation means providing a model with inputs and observing the outputs derived from those inputs (1:2). In order to accurately simulate these models, three crucial steps must be taken:

1. data gathering, model building, and validation
2. statistical design and estimation
3. programming and implementation

This thesis has accomplished the data gathering and model building steps listed above. Further researchers could

begin with validation of the models in this thesis and conclude with the programming and implementation step.

Bulletin Board Application. The use of other forms of electronic mail should be studied to possibly provide better information flow between USCENTAF/SC and AFRED/SC planners. Specifically, the use of an electronic bulletin board, as a running log of events during a deployment, would allow all participants easy access to the latest information concerning the deployment. "If you need to transfer files, leave messages for fellow workers and reach out to broad groups of people, bulletin board systems are an inexpensive, easy solution (18:83). An electronic bulletin board application on the Honeywell 6000 computer system is an option that should be examined. Most if not all computer hardware and communications equipment required to implement a bulletin board system is already available on the present Honeywell 6000 computer system.

Further Analysis of Each Model. To provide a better understanding of how the models in this thesis withstand added traffic loads, further research should include the effects a large scale mobilization would have on each system modeled. This thesis examined the AUTODIN system and electronic mail services available to USCENTAF/SC planners under peace time traffic loads only. To accomplish further research into the effects a large scale mobilization would

have on each system modeled, the following questions merit examination:

1. Can AUTODIN, fax, and Honeywell 6000 electronic mail services maintain present peacetime grade of service standards?
2. Is one system more susceptible to failure than the others during heavy loading or a range of disasters from high altitude nuclear detonations to flooding?
3. Can management procedures be made flexible enough to allow for one system to be substituted for another in the event of heavy loading or natural and man-made disasters?

Cost-Benefit Analysis. Further research should be conducted to compare the costs of training personnel to use the Honeywell 6000 electronic mail services to the benefits resulting from that training. To accomplish this comparison, a cost-benefit analysis is appropriate. A cost-benefit analysis involves "techniques for selecting the alternative that provides the greatest benefit at the lowest cost" (367:653). Answers to the following questions would be a starting point for a cost-benefit analysis to help estimate future costs and benefits:

1. Which individuals should be trained?
2. How much will it cost to train these people?
3. What are the qualifiable and quantifiable benefits resulting from this training?

Summary

This chapter looked at the conclusions reached as a result of the research that went into this thesis. Electronic mail services on the Honeywell 6000 computer were found to be overall more advantageous than AUTODIN or fax services. However, a manager should understand that Honeywell 6000 electronic mail, AUTODIN, and fax all have occasions where one method can be more advantageous than others. Therefore, one "best in every situation" model is not a conclusion of this research. Management should consider augmenting AUTODIN with the Honeywell 6000 electronic mail services and fax on a routine basis. Further research in the forms of computer simulations and a cost-benefit analysis will provide more information to make the augmentation question easier to answer. Also, a bulletin board application should be studied for applicability on the Honeywell 6000 computer system as the hardware and communications capability is already in place. Finally, each model should be evaluated to predict how it will perform under heavy loading caused by an increased demand for communications services under a contingency scenario.

Appendix A: Interview Questions for USCENTAF Planners

The following questions will be asked to the officers in charge (OICs) of the USCENTAF/SC exercise and contingency planning sections:

1. What forms of electronic mail are available for your planning section to use? This information is needed to find out what electronic mail systems, if any, are used by USCENTAF/SC planners. Also, the response to this question will show if the planners are aware of electronic mail services at Shaw AFB.

2. Are you aware of the electronic mail services available on the Honeywell 6000 computer? This question specifically narrows down the information provided in response to the first question to define what is available for their use.

3. For the planning required to perform your mission, do you use AUTODIN? Because this thesis compares AUTODIN and electronic mail systems found at Shaw AFB, the baseline importance that USCENTAF/SC planners rely on AUTODIN to complete their planning mission must be established. This question establishes that baseline.

4. How often and for what purposes does your planning section use AUTODIN to perform your planning duties? The response to this question provides the reader with a further (quantitative) understanding of how important AUTODIN is to each USCENTAF/SC planning section.

5. Do you or your planners use any other electronic methods (such as facsimile) to communicate text messages with planners at Langley AFB, and if so, what? This question is designed to aid in the completion of research objective number one.

6. If you answered yes to question five, explain what the method is and how often it is used. The response to this question is to expand the knowledge obtained in question five and aid in completing research objective number one.

7. How long does it usually take to type a one page message on a DD173? This question is for the USCENAF/SC Director of Administration and the response will aid in the construction of the various models to be built for comparing AUTODIN to electronic mail systems found at Shaw AFB.

8. Do your people have a user-id and password to access the Honeywell 6000 computer? The response to this question will provide the basis for the accessibility research variable for the Honeywell 6000 model.

9. Can your people type well enough to use a computer terminal? The response to this question will provide further information to be used in determining the accessibility research variable for the Honeywell 6000 model or any other electronic mail model requiring typing skills.

Appendix B: Interview Questions for AFRED Planners

The following questions were asked to 1st Lieutenant Margaret Russell a planner with the Hq TAC/SCTCL plans and programs office at Langley AFB to ensure the proper equipment was available for electronic mail communications with Shaw AFB:

Question. Where is the closest Honeywell 6000 computer terminal to your office? This answer will establish the fact that Honeywell 6000 terminals are available for use by AFRED/SC planners.

Response. A Honeywell 6000 terminal is available in the Hq TAC/SC building that houses the AFRED/SC planners.

Question. Do planners at Langley AFB have access to a common user fax machine? This answer will establish the fact that a common user fax machine is available for fax communications with Shaw AFB.

Response. Yes common-user fax service is available.

Appendix C: USCENTAF Interview Responses

The following questions were asked to the officers in charge (OICs), or the officer designated by the OIC, of the USCENTAF/SC exercise and contingency planning sections:

LtCol George Roberts, OIC USCENTAF/SC Exercise Plans:

Question. What forms of electronic mail are available for your planning section to use?

Response. Facsimile and Honeywell 6000 electronic mail services.

Question. Are you aware of the electronic mail services available on the Honeywell 6000 computer?

Response. Yes, but my planning section does not use them.

Question. For the planning required to perform your mission, do you use AUTODIN?

Response. Yes.

Question. How often does your planning section use AUTODIN to perform your planning duties?

Response. Approximately 25 per week with five messages going to Langley AFB.

Question. Do you or your planners use any other electronic methods (such as facsimile) to communicate text messages with planners at Langley AFB, and if so, what?

Response. Yes.

Question. If you answered yes to question five, explain what the method is and how often it is used.

Response. Facsimile is used about once per week for things like awards and decorations.

Question. Do your people have a user-id and password to access the Honeywell 6000 computer?

Response. Yes.

Question. Can your people type well enough to use a computer terminal?

Response. Yes.

Captain Paul Rigney, speaking for the OIC USCENTAF/SC

Contingency Plans:

Question. What forms of electronic mail are available for your planning section to use?

Response. Facsimile and Honeywell 6000 electronic mail services. Also, the DDN (Defense Data Network). Defense Data Network is not used because the people that we wish to communicate with do not know how to use the DDN.

Question. Are you aware of the electronic mail services available on the Honeywell 6000 computer?

Response. Yes but my planning section does not use them.

Question. For the planning required to perform your mission, do you use AUTODIN?

Response. Yes.

Question. How often does your planning section use AUTODIN to perform your planning duties?

Response. Approximately 5 per week.

Question. Do you or your planners use any other electronic methods (such as facsimile) to communicate text messages with planners at Langley AFB, and if so, what?

Response. Yes.

Question. If you answered yes to question five, explain what the method is and how often it is used.

Response. Facsimile is rarely ever used.

Question. Do your people have a user-id and password to access the Honeywell 6000 computer?

Response. Yes.

Question. Can your people type well enough to use a computer terminal?

Response. Yes.

This question was for the Director of Administration for USCENTAF/SC. The Director of Administration was not available for questioning during the site survey, therefore the acting director Sgt. Wayne T. Boyette provided the response.

Question. How long does it usually take to type a one page message on a DD173? The answer to this question will provide information to complete the AUTODIN communications model.

Response. Approximately four minutes.

Appendix C revealed that electronic mail services available to USCENTAF/SC planners included Honeywell 6000 electronic mail services and facsimile. However, Honeywell 6000 electronic mail services were not used and facsimile was only rarely used. Although Honeywell 6000 electronic mail services were not used, most planners possessed user-ids and passwords to use the Honeywell 6000 computer. It

was also found that AUTODIN is used at least daily to communicate with Langley AFB, and that the exercise plans section uses AUTODIN more than the contingency plans section.

Appendix D: Model Element Calculations

AUTODIN

	Value rating		Score		Subtotal
SECURITY	1	X	1	=	1
TIME	2	X	3	=	6
ACCESSIBILITY	3	X	1	=	3
TOTAL			10		

HONEYWELL 6000

TERMINAL-TO-TERMINAL AND ELECTRONIC MAIL

	Value rating		Score		Subtotal
SECURITY	1	X	1	=	1
TIME	2	X	1	=	2
ACCESSIBILITY	3	X	2	=	6
TOTAL			9		

HONEYWELL 6000

CONSOLE

	Value rating		Score		Subtotal
SECURITY	1	X	1	=	1
TIME	2	X	1	=	2
ACCESSIBILITY	3	X	-	=	-
TOTAL			-		

FAX					
	Value rating		Score		Subtotal
SECURITY	1	X	2	=	2
TIME	2	X	2	=	4
ACCESSIBILITY	3	X	1	=	3
TOTAL					11

Appendix E: Personnel Interviewed

This appendix lists those individuals interviewed for information to complete this research:

Boyette, Wayne. Sergeant, USAF, USCENTAF/SC.

Ferens, Daniel. Assistant Professor, AFIT/LS.

Luneke, Kenneth. Lead Computer Specialist.

Odom, Fredrick. Master Sergeant, USAF, USCENTAF/SC.

Poe, Billy J. Technical Sergeant, USAF, USCENTAF/SC.

Rielly, Pat. Honeywell 6000 Computer expert. 1913CG/DO.

Rigney, Paul. Captain, USAF, USCENTAF/SC.

Roberts, George. Lieutenant Colonel, USAF, USCENTAF/SC.

Russell, Margaret. 1st Lieutenant, USAF, HQ TAC/SC.

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Vita

Captain Severin is a distinguished military graduate of the University of South Carolina where he received a Bachelors of Science Degree in Geology. He received a reserve commission as a Second Lieutenant concurrent with his graduation in May 1980. Shortly after he was commissioned, he was stationed at Keesler AFB, Mississippi where he completed the Communications-Electronics Officer Basic Course.

Shaw AFB was his first assignment, after Keesler AFB, where he began duties as a communications-electronics contingency planning officer for the Rapid Deployment Air Force Forces component of the Rapid Deployment Joint Task Force. In 1984, he was assigned to the 2035 Communications Squadron as the Chief, Communications-Electronics Operations Branch where he served until coming to the Air Force Institute of Technology in 1986.

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